

Three Years of CO₂ Retrievals with AIRS

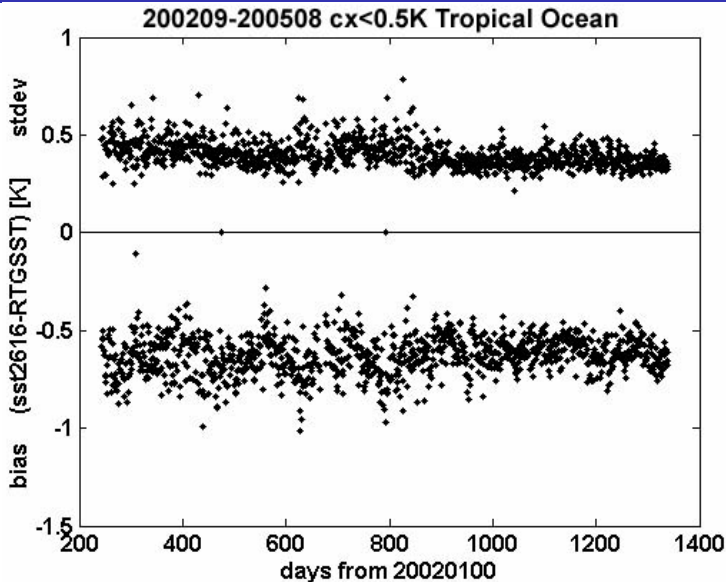
L.Larrabee Strow and Scott Hannon

Atmospheric Spectroscopy Laboratory (ASL)
Physics Department
and the
Joint Center for Earth Systems Technology

University of Maryland Baltimore County (UMBC)

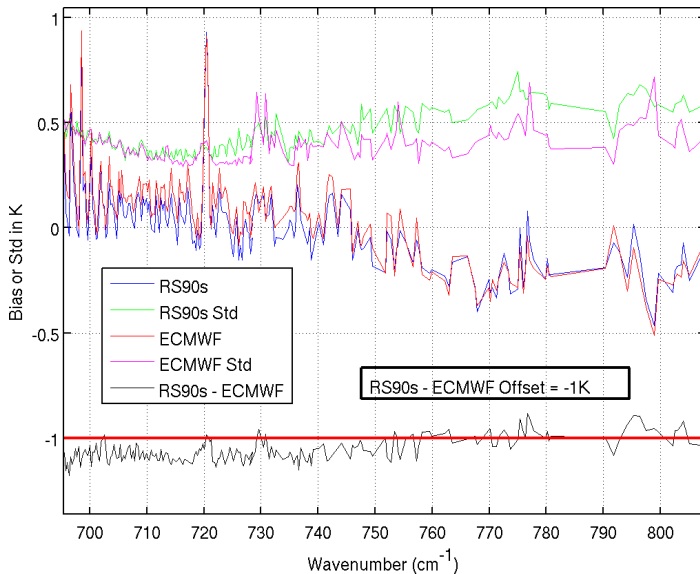
September 26, 2006

- During RTA validation found that CO₂ growth rate impacted results
- Variable CO₂ must be taken into account for climate-quality results from AIRS (and RTA validation);
- V5: Single fixed growth rate, no latitude dependence
- Retrievals of CO₂ using only AIRS data have concentrated on upper-trop channels and have not examined long time-series.
- We use ECMWF (independent T(p)?) and NOAA/CMDL MLO CO₂ to examine AIRS sensitivity to CO₂ and implications for radiometric stability
- Calibrate AIRS CO₂ channels with MLO (altitude close peak of weighting functions for channels used here).
- Apply results to other latitudes. Use channels with different T(p) sensitivities to evaluate possible ECMWF T(p) errors.
- Use “uniform_clear” subset of clear ocean FOVS generated at UMBC.



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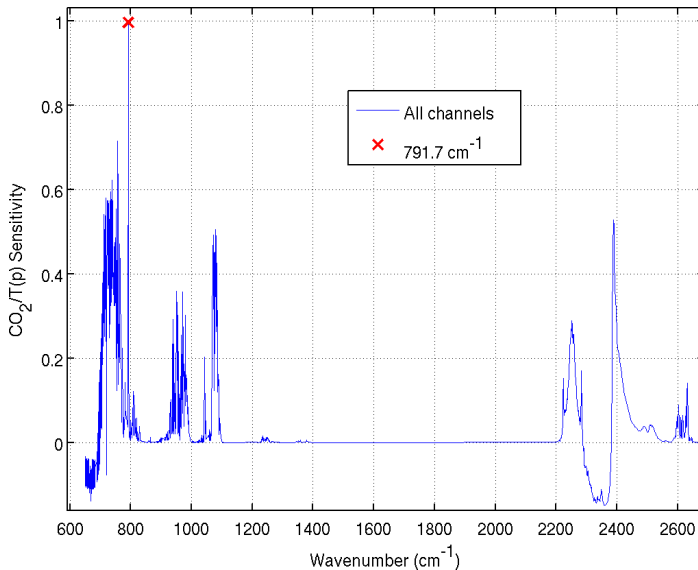


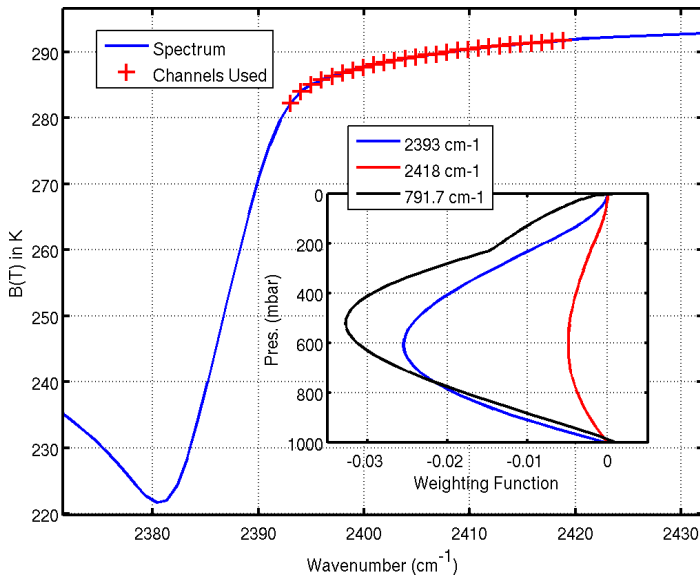
- Need to use mid- to lower-tropospheric channels since “truth” is known there (Mauna Loa record).
- ECMWF fields are largely unbiased relative to radiosondes for lower- to mid-trop, esp. Northern Hemisphere. (private comm. R. Engelen).
- Retrieve CO₂ from AIRS radiances using ECMWF for T(p).
- Compare retrieved CO₂ to NOAA/CMDL MLO, located at ~650 mbar.
- Test sensitivity to ECMWF T(p) by using channels with very different temperature sensitivities.
- Pick CO₂ channels away from interferences
- Channels: 791.7 cm⁻¹, and 2392-2400 cm⁻¹, CO₂ W.F. peaks around MLO altitude.

Ratio of CO₂ to T(p) Jacobians

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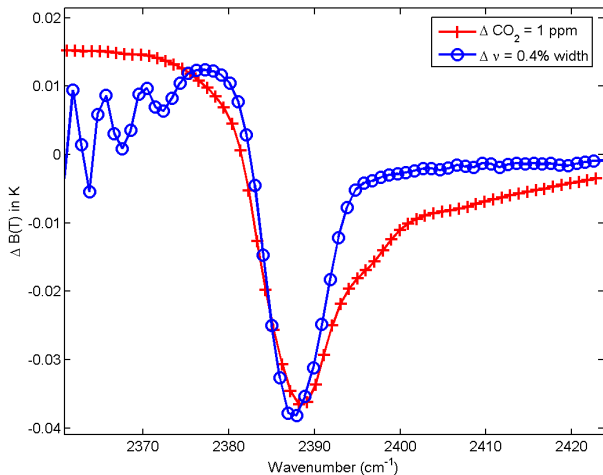
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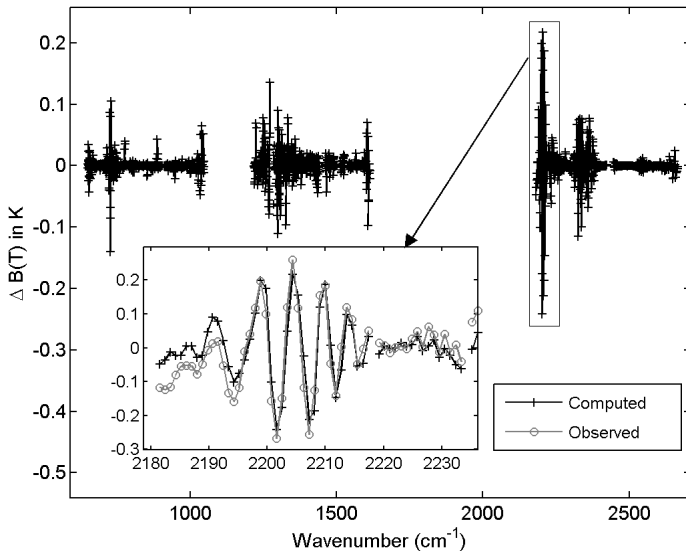
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AIRS Radiances Have a 1-time offset in Nov. 2003: Avoid

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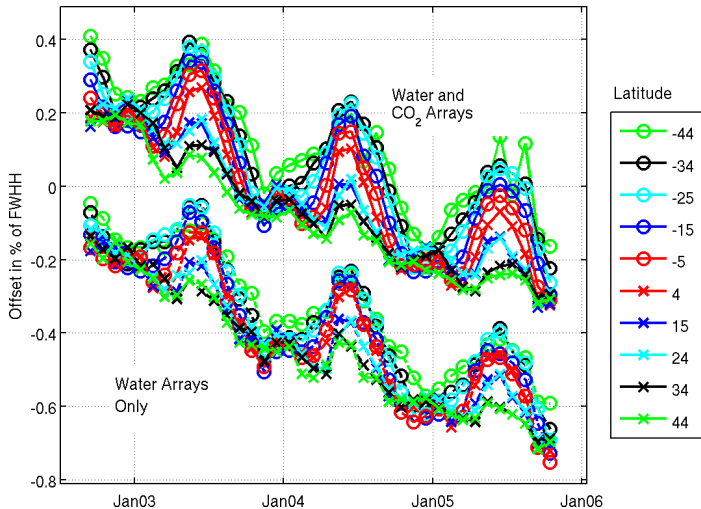


AIRS Freq. Cal. Results

Daytime Frequency Shifts (Nov. 2003 Corrected)

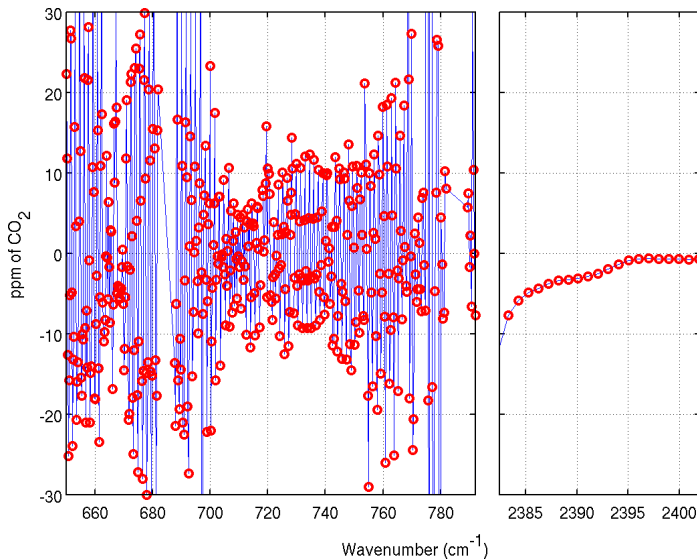
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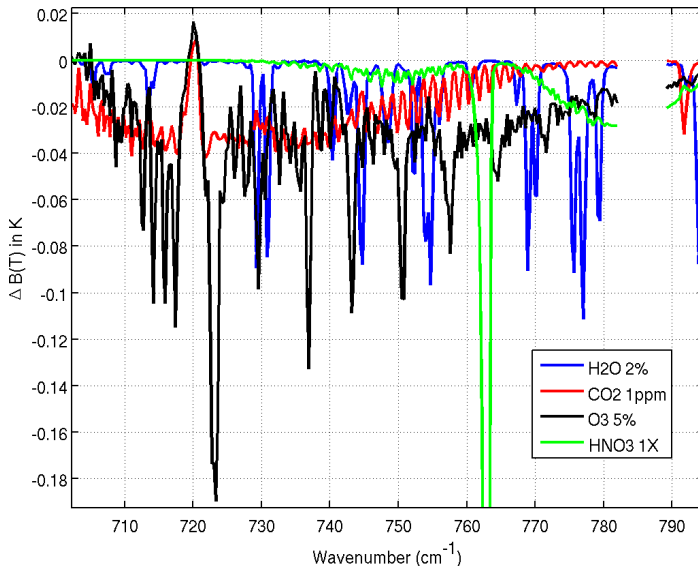
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Contamination of CO₂ Channels by Other Gases: LW

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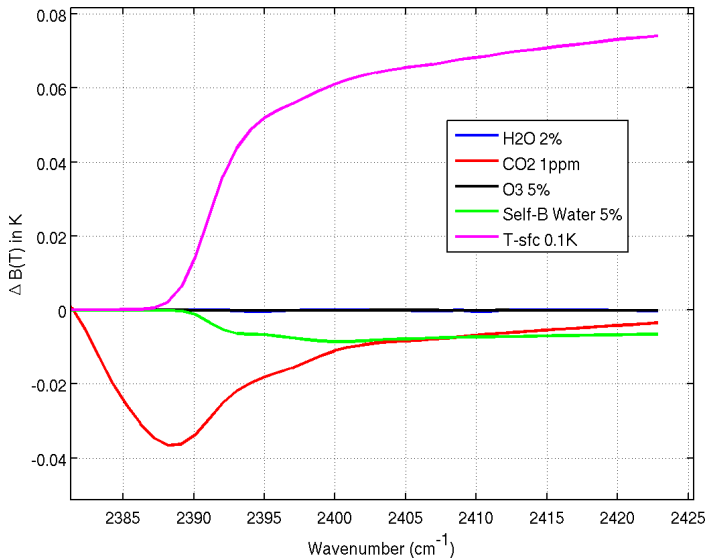
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Contamination of CO₂ Channels by Other Gases: SW

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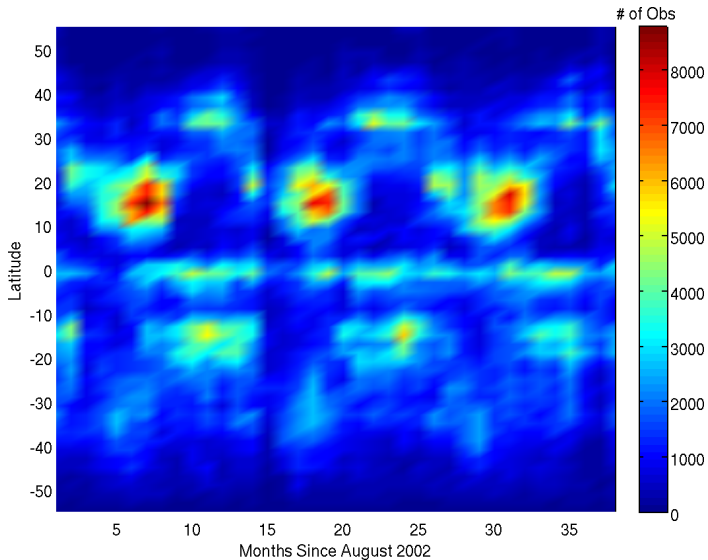


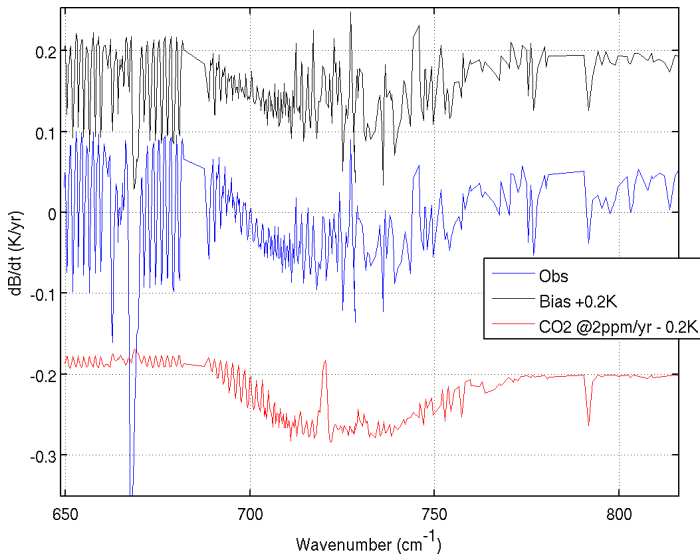
- $BT_{obs} - BT_{calc}(ECMWF) = \frac{dB}{dCO_2} \delta CO_2 + \frac{dB}{dT} \delta T_s$
- SW: 2392-2420 cm⁻¹, all channels used for both CO₂ and T
- LW: 791.7 cm⁻¹ used for CO₂ and T_s; 790.3 and 801.1 cm⁻¹ used for T_s only.
- CO₂ and T_s solved for each profile, Start with 2616 cm⁻¹ T_s. Probably solving for emissivity at 2400 cm⁻¹, residual H₂O and emissivity at 791 cm⁻¹.
- Median CO₂ and T_s binned for 1 deg. latitude bins
- 38 months of data analyzed
- Error analysis not complete

Clear FOV Observation Statistics

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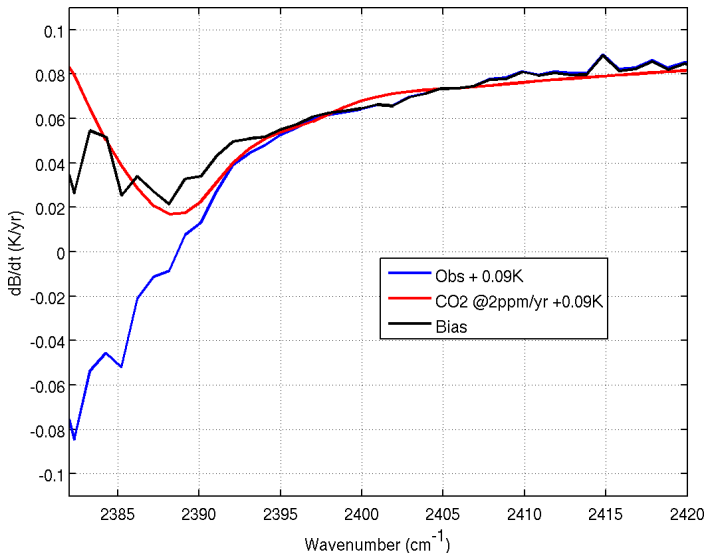
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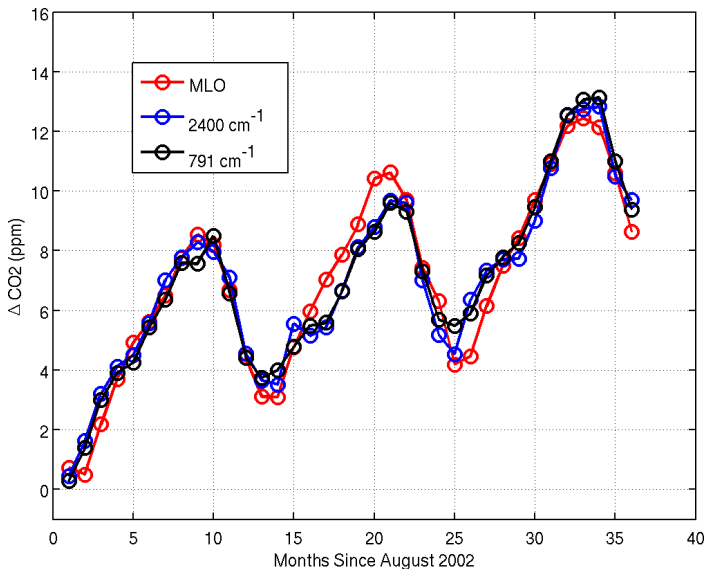
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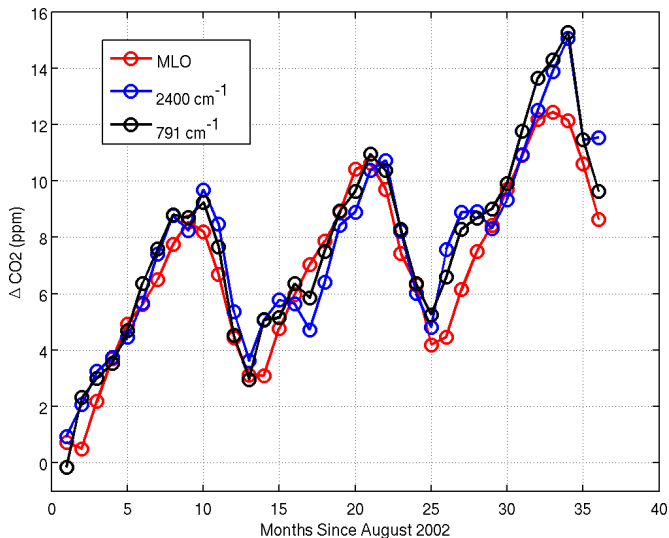
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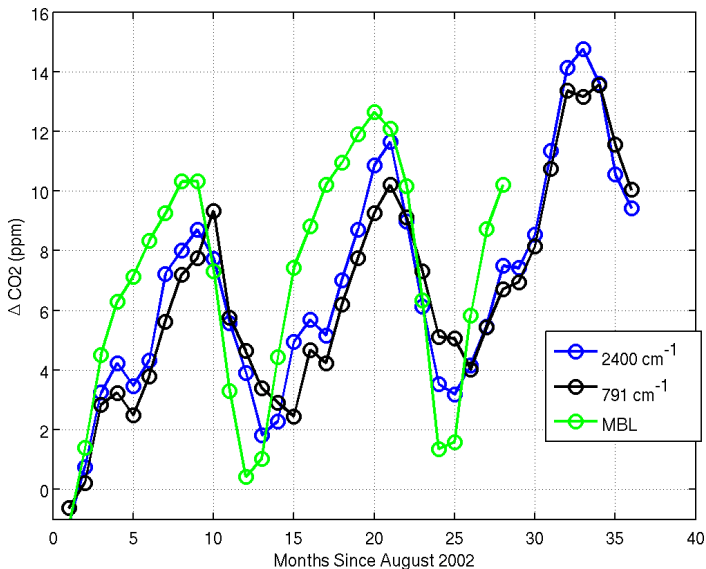
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AIRS CO₂ Retrievals 35-45 Deg. Lat.,
+NOAA/MBLThree Years of
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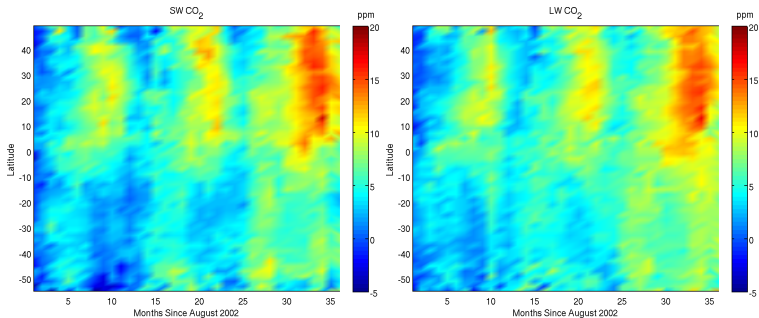
AIRS 3-Year CO₂, SW and LW

Correlation = 0.89

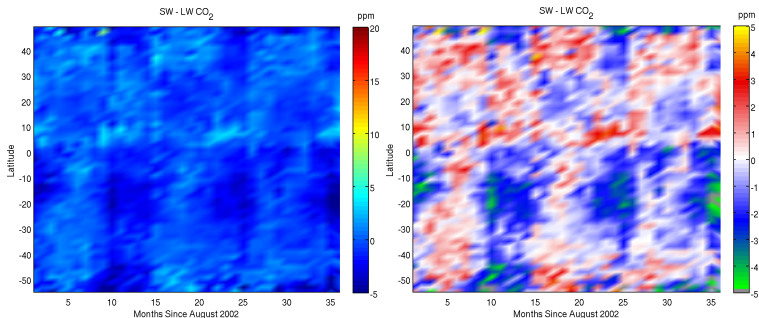
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Left: Shortwave Right: Longwave



Left: -5 to +20 ppm Right: -5 to +5 ppm

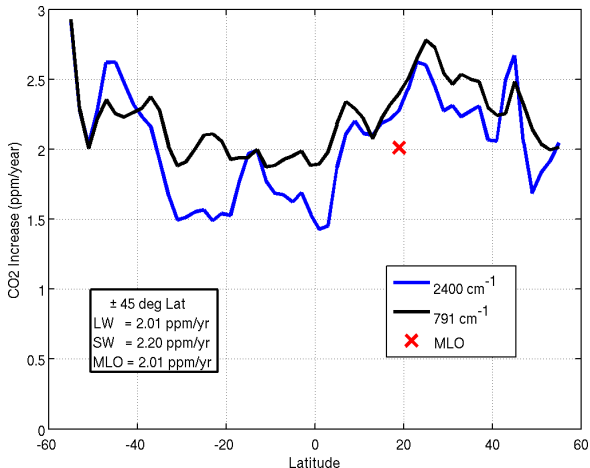


Mean CO₂ Growth Rate over 1st 3 Years

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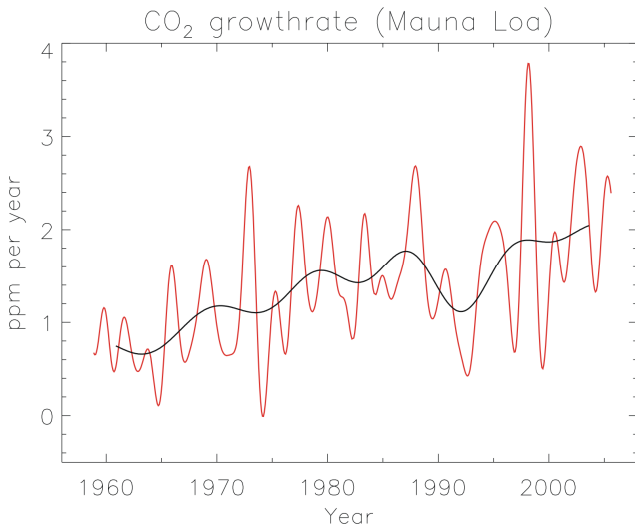
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± 45 Deg. Lat. SW vs LW rates imply AIRS stability of $\sim 0.002 - 0.006$ K/year



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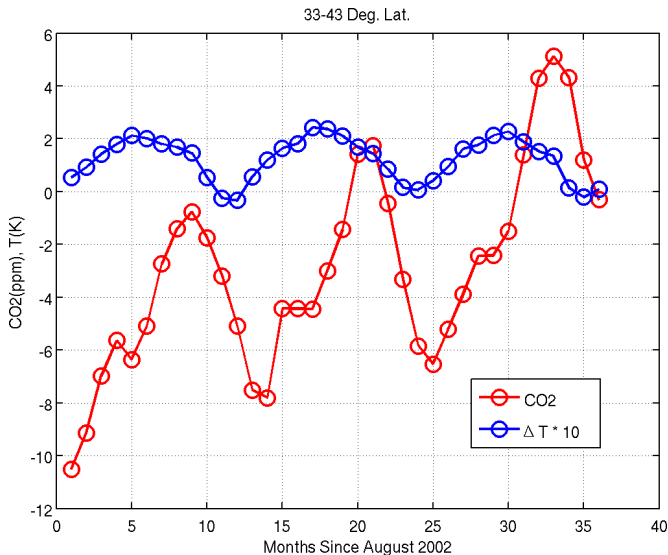
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Retrieved CO₂ vs T in Northern Hemisphere

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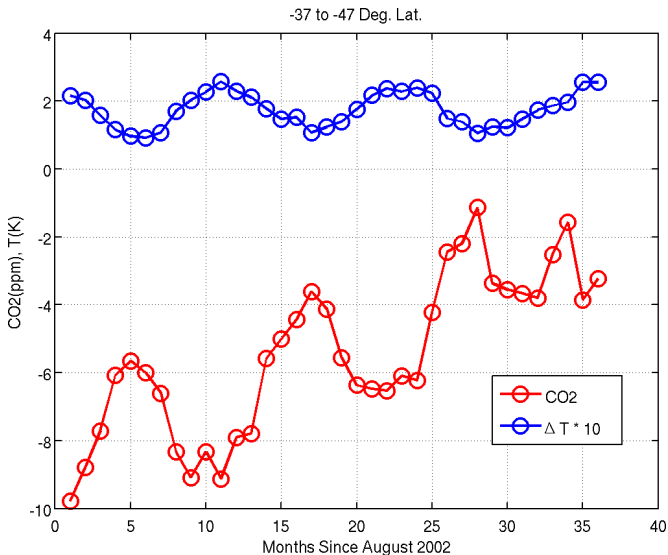
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Retrieved CO₂ vs T in Southern Hemisphere

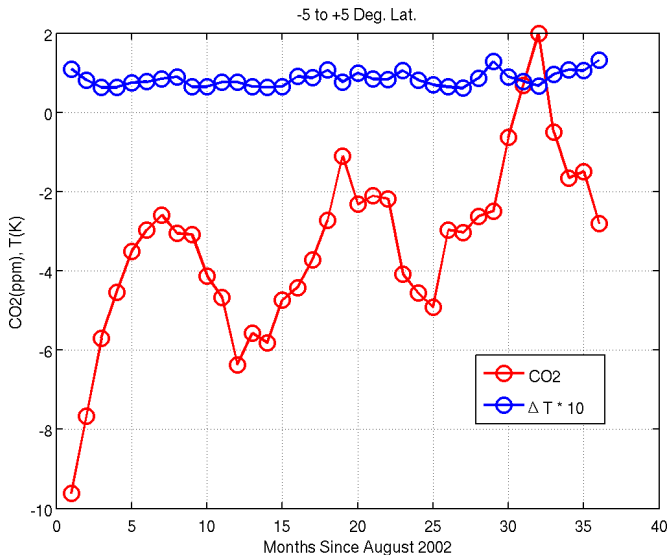
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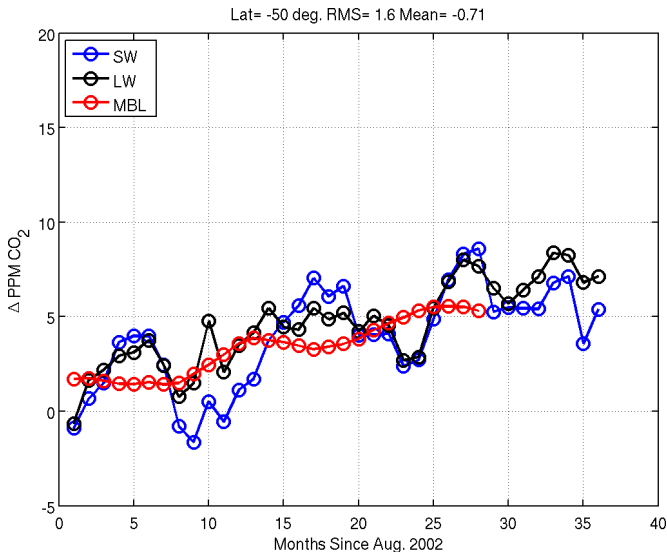
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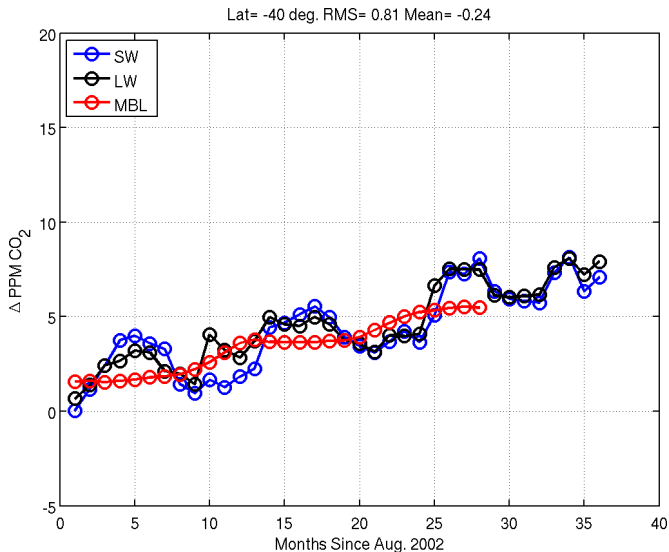
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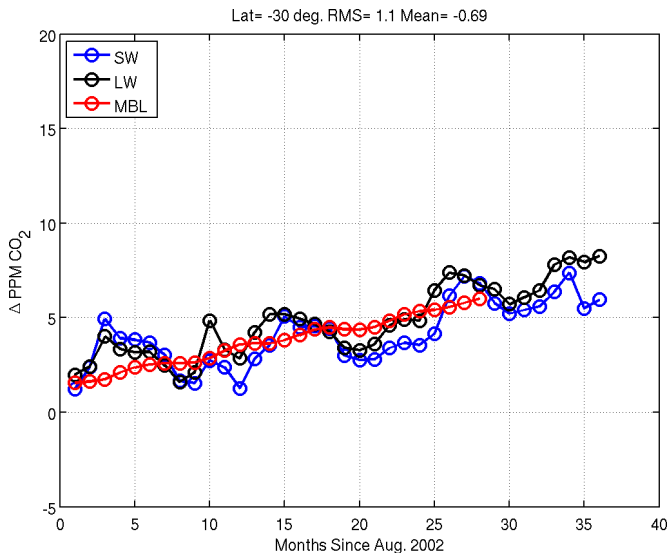


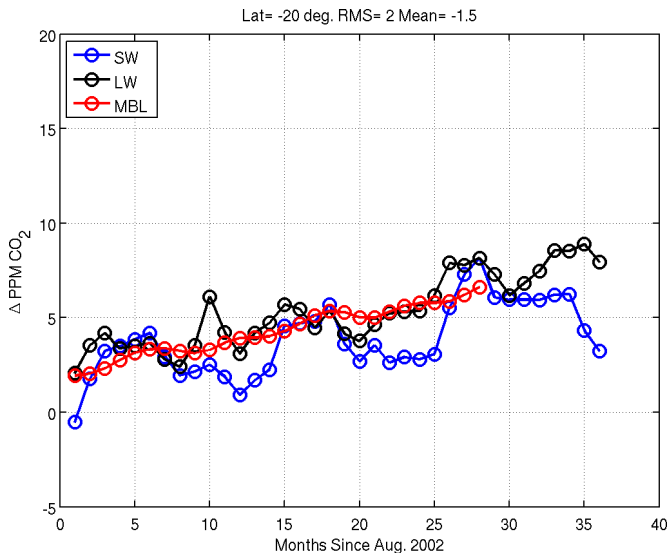
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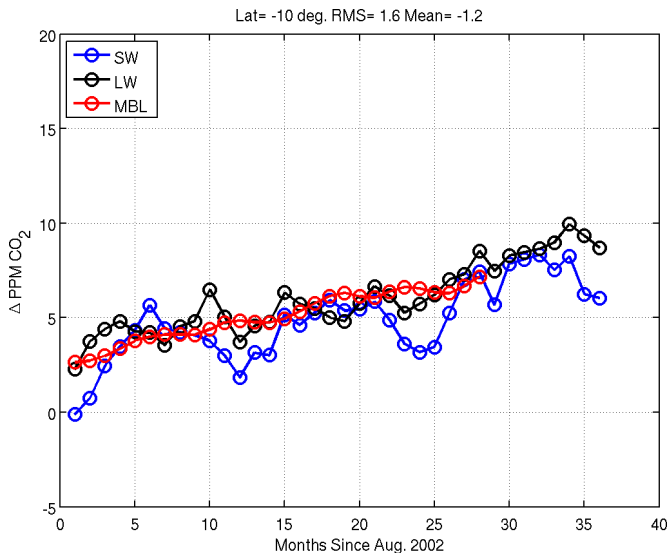
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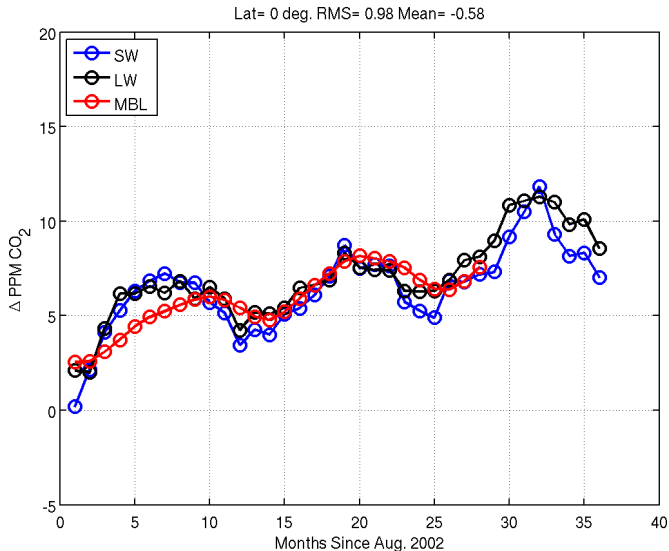


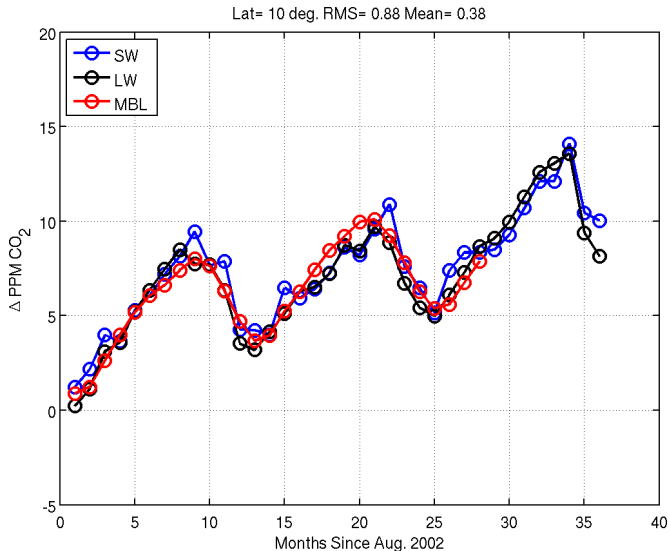


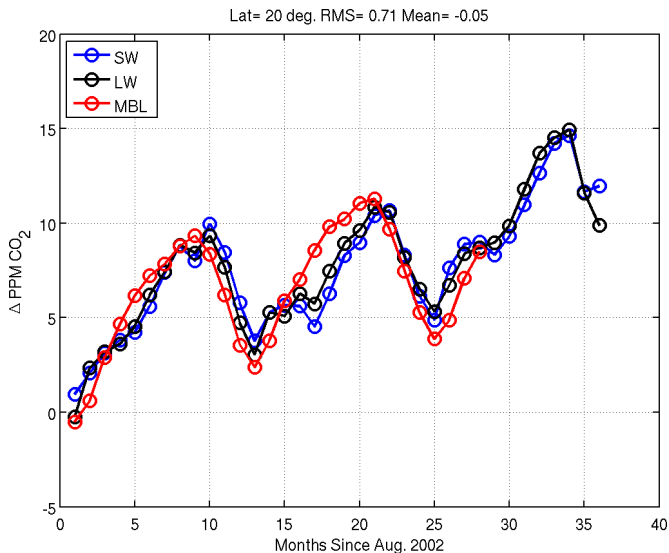


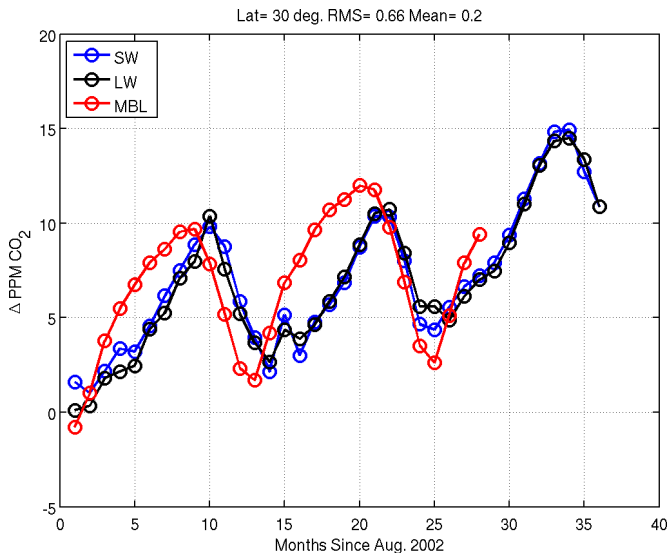


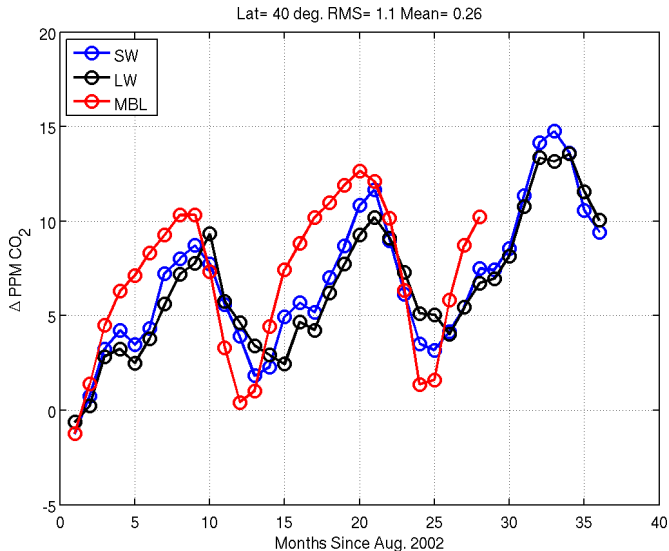


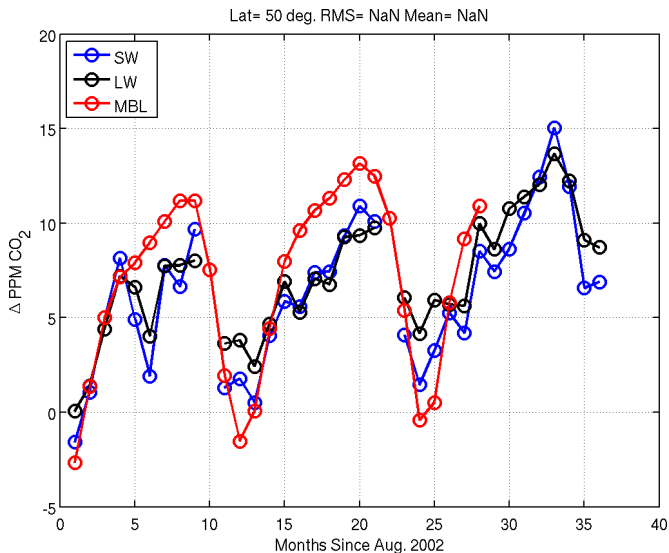








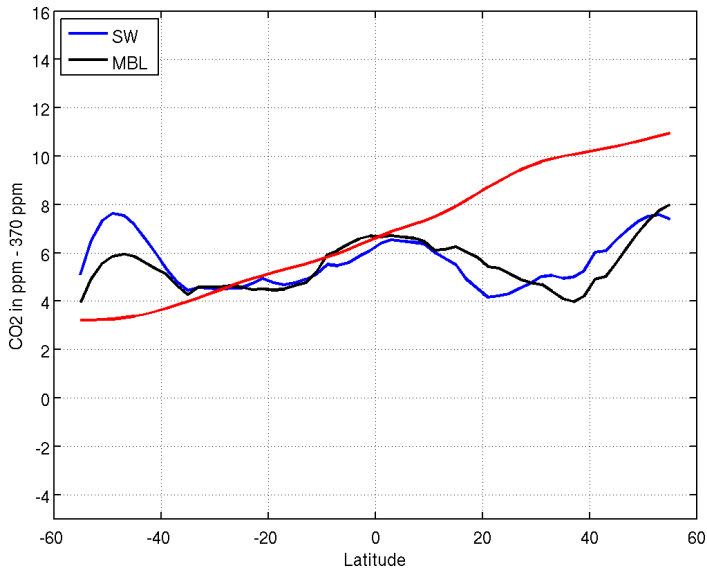




- AIRS radiometric stability at the $\sim 0.005\text{K/year}$ established with 791 and 2400 cm^{-1} channels, in agreement with Aumann SST studies.
- AIRS sees phase delay from surface to mid-trop CO₂ transport
- Potentially retrieve CO₂ growth rates versus latitude, good agreement with NOAA/CMDL MLO in-situ measurements
- Results dependent on UMBC spectral calibration

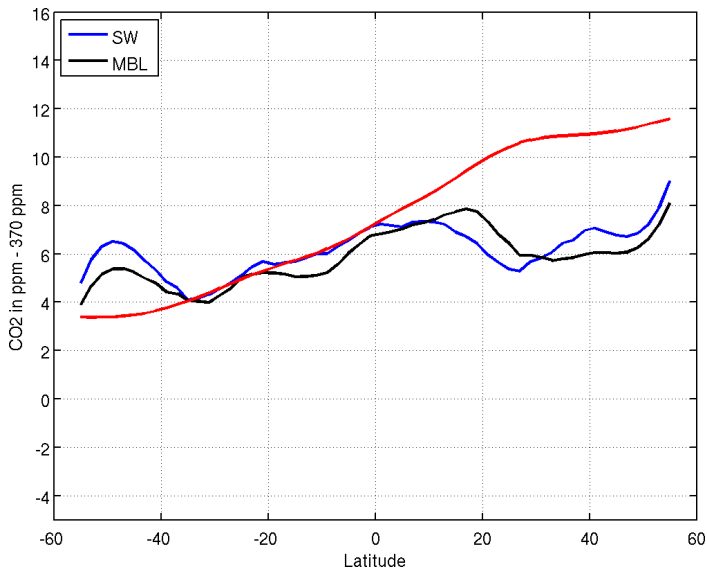
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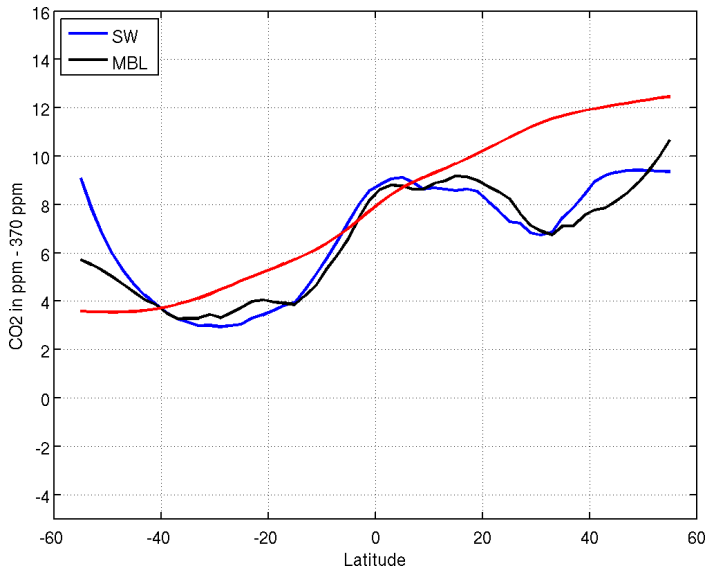
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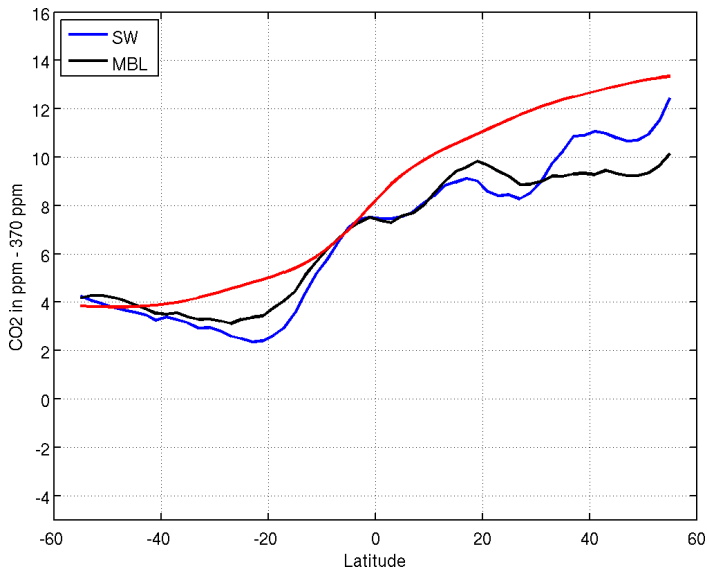
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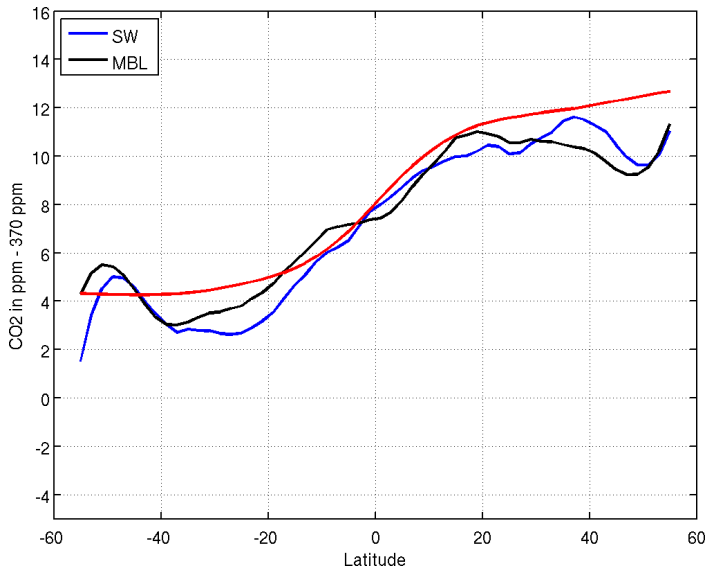
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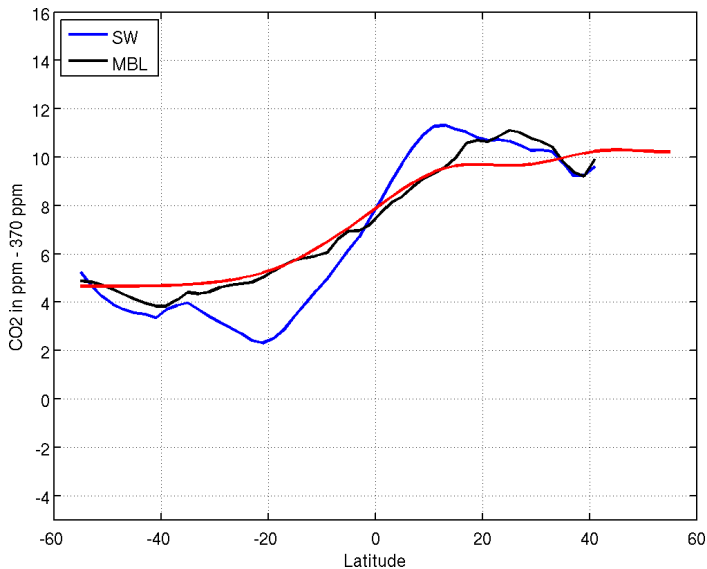
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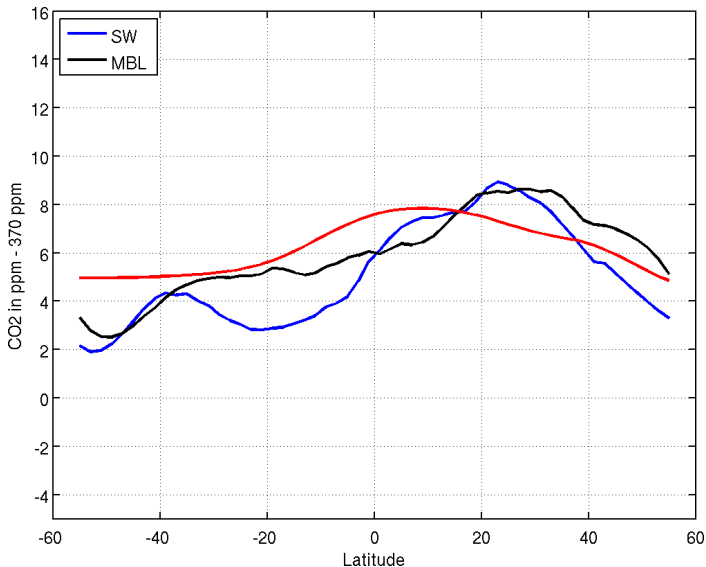
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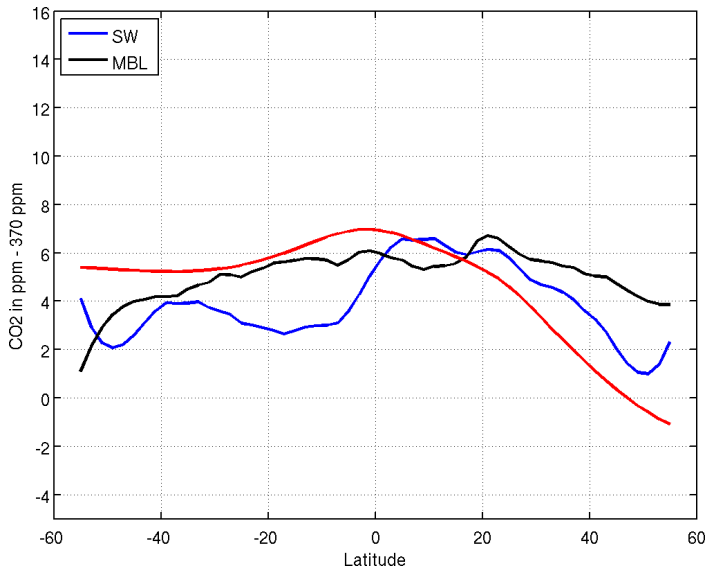
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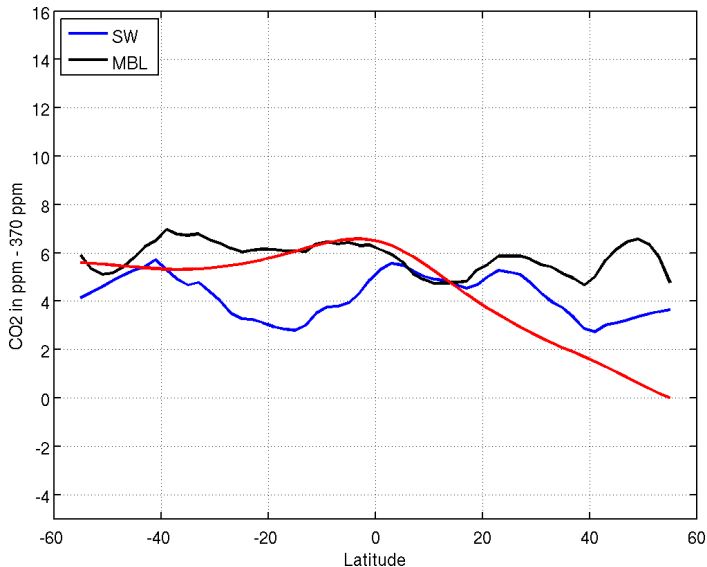
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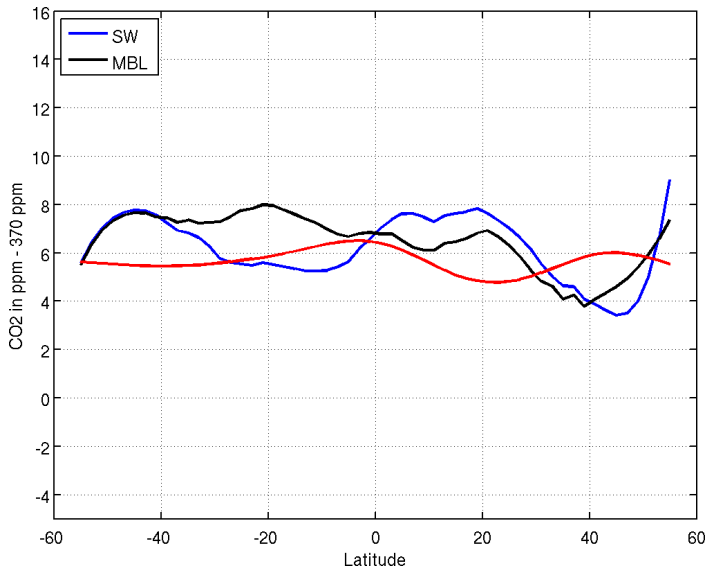
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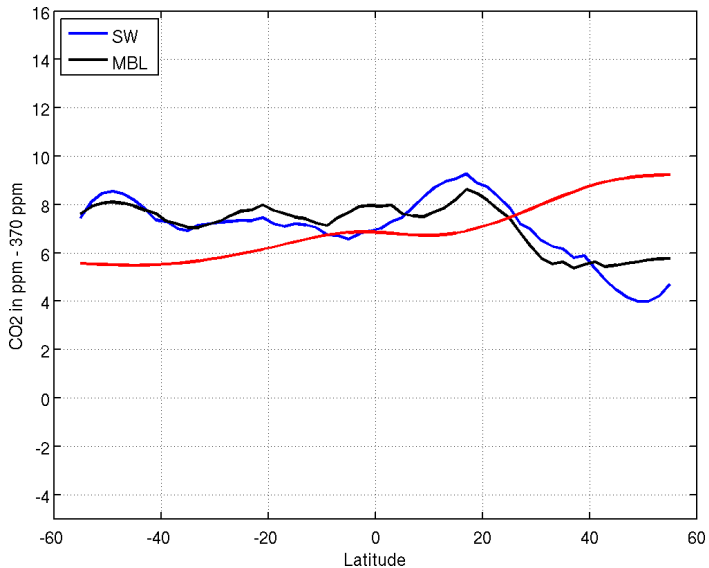
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